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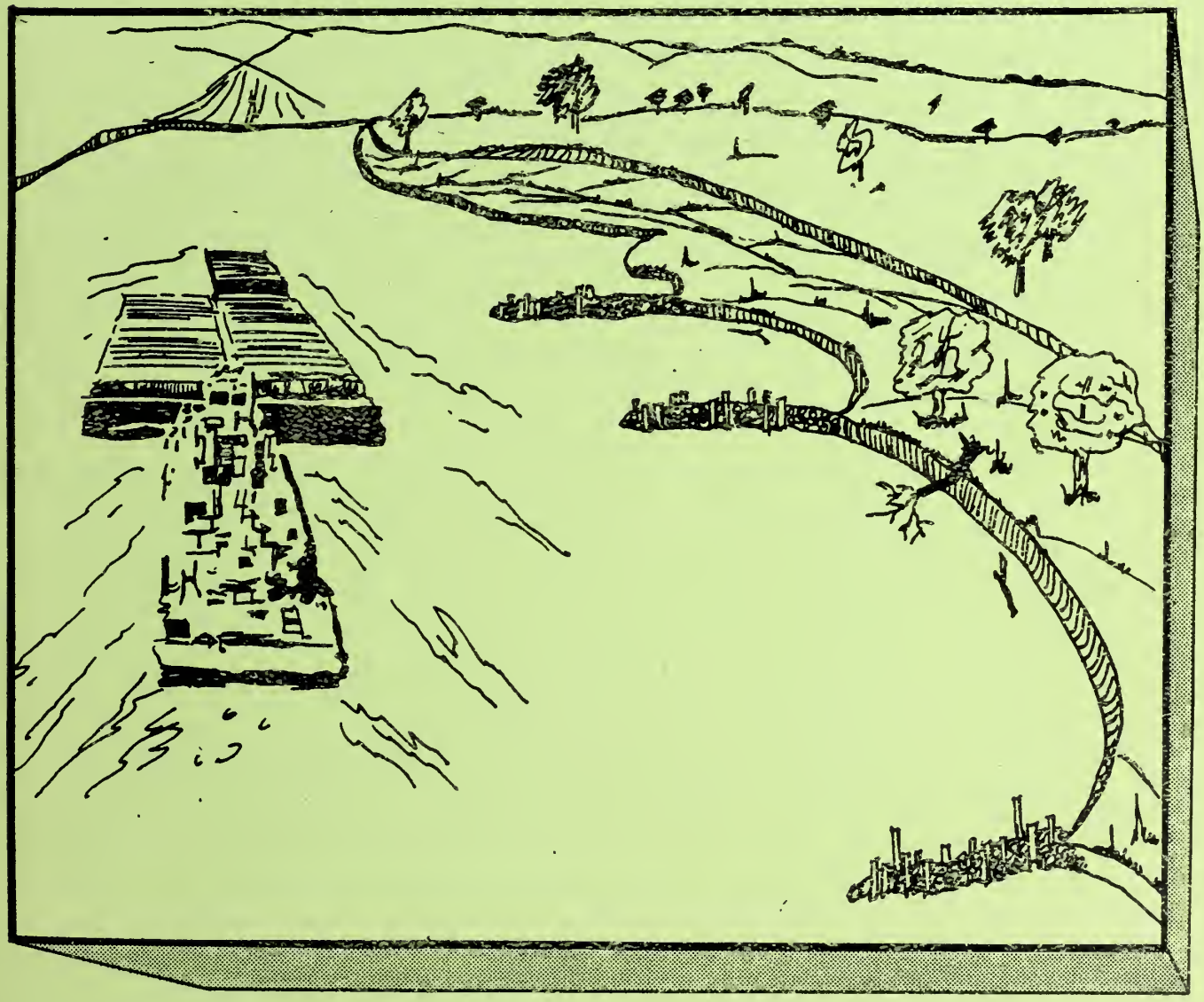
MISSOURI RIVER PRESERVATION AND DEVELOPMENT PROJECT

AN ECONOMIC ANALYSIS OF THE IMPACT OF WATERWAY USER CHARGES ON COMMERCIAL NAVIGATION TO SIOUX CITY, IOWA



SIOUXLAND INTERSTATE METROPOLITAN PLANNING COUNCIL

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MISSOURI RIVER PRESERVATION AND DEVELOPMENT PROJECT: AN ECONOMIC ANALYSIS OF THE IMPACT OF WATERWAY USER CHARGES ON COMMERCIAL NAVIGATION TO SIOUX CITY, IOWA.

Prepared for the

OLD WEST REGIONAL COMMISSION

by the

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July 1, 1978

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1.0 SUMMARY

This study was undertaken to evaluate various user charge proposals and measure their potential impacts upon navigation at Sioux City, Iowa. It includes background material on the movement to impose user charges on America's inland waterway system, a comparison of the characteristics exhibited by various transportation modes, an evaluation of line-haul transportation rates to Sioux City by water and via the assumed least cost alternative (rail), an estimation of increased shipping costs due to imposition of selected types of user charges, and an examination of the impacts of potential user charges on navigation at Sioux City and on the economy as a whole.

Conclusions of the study are that while water transportation is less expensive than other modes, a user charge of any type, set at any level, will adversely affect navigation at Sioux City. Of the two major user charge forms, segment tolls and fule taxes, the impacts of the former are much more severe, resulting quite possibly in the eventual cessation of commercial navigation on that segment of the Missouri River between Sioux City and Omaha. Fuel taxes may reduce navigation somewhat, although the increased costs are apparently not so great that they can't be absorbed efficiently.

2.0 INTRODUCTION AND BACKGROUND

User charges are fees which are assessed by a government against individuals or groups which derive a direct benefit from a government funded improvement. Such charges are utilized when the benefit accrues only to specific individuals or groups rather than the general public. Partial or complete funding of transportation projects is frequently accomplished through some form of user charge. Automobiles and trucks pay tolls to operate on certain of the nation's highways and bridges. In addition, trucks are assessed fuel taxes and pay various permit fees. Commercial aircraft pay fuel and ticket taxes in addition to landing fees for use of U.S. airports and air control systems. Furthermore, while the railroads in certain instances receive Federal subsidies, they regularly pay substantial property taxes. Although user charges have been well received as funding sources for these modes of transportation, their use to finance waterways improvements has never been accepted as appropriate national policy.

America's history of Federal responsibility for waterways improvement without toll or tax is quite extensive. The Northwest Ordinance of 1787, adopted as the governing statute of the Northwest Territory (that area north of the Ohio River and east of the Mississippi River consisting of the present states of Ohio, Indiana, Illinois, Michigan, Wisconsin, and a portion of Minnesota) initiated the free waterway policy of the United States. Article IV of the Ordinance addressed the issue as follows:

> The navigable waters leading into the Mississippi and St. Lawrence, and carrying places between the same, shall be common highways and forever free, as well to the inhabitants of said territory as to citizens of the United States, and those of other States that may be admitted into the confederacy, without any tax, impost or duty therefor.

Congress first assumed responsibility for waterway improvements near the beginning of the 19th Century to encourage economic development and instill a spirit of national unity through what was termed the "American System" of internal improvements. At that time there were few transportation alternatives in the exploration and development of a wilderness country. President Andrew Jackson reaffirmed an executive policy of presidential support for Federally-funded internal improvements in his Annual Messages of 1829 and 1830. In the latter year, he stated: "All improvements effected by the funds of the Nation for general use should be open to the enjoyment of all of our fellow citizens, exempt from payment of tolls or any imposition of that character."

Shortly thereafter, the Federal Government initiated funding of navigational improvements on the Mississippi River. The first of these consisted of snag, shoal and sand bar removal; as well as dynamiting and excavating rock to provide clear passage. Congress authorized the first comprehensive project on the upper Mississippi in 1878; a 4½-foot channel to aid commercial traffic and encourage its growth. A number of dangerous rapids were completely by-passed through construction of short parallel canals with a series of navigation locks. In 1907, Congress approved increasing the depth of this channel to 6 feet. A 6-foot channel was achieved primarily by constructing numerous rock and brush "wing dams" extending from the shore out into the river to constrict the water's flow. Following exhaustive study, Congress, in 1930, authorized the present 9-foot channel configuration on the upper Mississippi from its confluence with the Missouri River north to Minneapolis. The increased depth was to be obtained by means of an extensive system of locks and dams, supplemented by channel dredging as necessary.

Federal concern with establishing a viable water transportation system is further indicated by the fact that in 1918 the government initiated a barge line on the Mississippi River and its tributaries. Public operation was intended to stimulate investment by the private sector in navigation related facilities and encourage usage of future river improvements. The government served as the major barge operator for over 40 years, however as competition began to appear the Federal Barge Lines was sold to a private concern.

Waterway improvements on the Missouri River initially consisted of snag removal by the U.S. Army Corps of Engineers. Congressional actions in 1912 authorized a 6-foot deep, 200-foot wide navigation channel on the lower reaches of the river between Kansas City and the mouth. Legislation in 1927 extended the authorization upstream to Sioux City. The current Missouri River Bank Stabilization and Navigation Project, authorized by the River and Harbor Act of 1945, is a multi-purpose river development project addressing navigation, bank stabilization and recreation. It extended the navigation limits of the earlier congressional authorizations by providing for a continuous 9 foot navigation channel, 300 foot wide from Sioux City, Iowa to the mouth, a distance of approximately 732 miles.

The Missouri River Bank Stabilization and Navigation Project utilizes an open-river design, relying on the scouring action of the flowing water, rather than a system of locks and dams, to develop and maintain the desired channel. Authorized dimensions now exist within portions of the project area which has a designed, stabilized width varying from 600 feet at Sioux City to 1,100 feet at the mouth. Certain stretches of the river are troubled by the settling out of sediments from the silt-laden waters and, therefore, it has been impossible to maintain the desired channel design over the entire project length.

American waterway users still are able to utilize the government built and maintained inland waterway system without "...any tax, impost, or duty..." All navigable rivers and canals of the United States enjoy this federal subsidy. In other parts of the world, however, fees are regularly assessed for waterway passage. For example, users of the St. Lawrence Seaway pay a seaway fee and users of the Welland Canal connecting Lake Erie with Lake Ontario are assessed $800 for utilizing the canal's 8 locks. Similarly, fees are charged for passing through both the Panama and Suez Canals. It appears more and more likely that some form of user charge will be levied against users of America's domestic waterways in the near future.

The concept of a user charge or tax on waterborne commerce is not of immediate origin. This matter was brought to the attention of the public by the Second Hoover Commission's report in 1955 which recommended that users of inland waterways be assessed fees sufficient to recover the costs of operating and maintaining the system. In the 23 years since then, a number of user charge proposals varying in both scope and magnitude have been forwarded. Impetus for many of these proposals has come primarily from the Executive Branch.

Congressional studies released in early 1961 reached opposing conclusions concerning user charges. The Senate Interstate and Foreign Commerce Committee's Special Study Group on Transportation suggested a complex system of waterway charges be implemented which would generate enough funds to recover all current Federal cash expenditures. Conversely, the Senate Select Committee on National Water Resources stated that it was "not overly concerned with the cost sharing aspect of our water resources problems, because it believes that the present policies tend to even out the sharing of costs over the long run, among all the people".

Between 1964 and 1969, the Executive Branch annually submitted draft legislation which called for a tax beginning at 2 cents per gallon on fuel used by vessels with a draft of 15 feet or less. One such proposal would have required incremental annual increases in the fuel tax of 2 cents per gallon over a five-year period, ultimately a tax of 10 cents per gallon. None of these proposed bills were ever introduced in Congress.

Congress created a seven-member National Water Commission in 1968 to assess water resources programs, problems and policies. This Commission issued a preliminary report in November 1972 and a final report in June of 1973. The preliminary report proposed imposition of fuel taxes and lockage fees so that, "within the bound of administrative feasibility, the user charges for individual waterways, or classes of waterways, reflect differences in the cost of operating and maintaining them". In the final report, however,

the Commission modified its view by recommending fuel taxes and lockage fees which would be constant over "integral segments of the total waterway system".

Late in 1974, President Ford suggested legislation imposing user charges in the form of ton-mile taxes on twenty specified shallow-draft waterway segments at a sufficiently high level to recover total nvaigation-related operation and maintenance costs on each waterway. Subsequently, the U.S. Department of Transportation developed a proposal levying 4 cents per gallon on all fuel used by vessels having a maximum draft of up to 15 feet. This 1975 proposal was to be applied to both commercial and recreational vessels and was anticipated to generate approximately $100 million annually.

Since that time various user charge proposals have surfaced in Congress, although as of July, 1978, none have passed both Houses and been signed into law by the President. It appears, however, that one of the several proposals presently pending will eventually become law, due in large measure to the fact that the Administration has repeatedly stated that President Carter will not sign any bill authorizing replacement of the rapidly deteriorating Lock and Dam 26 on the Mississippi River unless that bill also provides for imposition of some type of user charge. The vital nature of this facility to the continuation of efficient navigation on the upper Mississippi River system makes its replacement enormously important, thus virtually assuring its eventual passage and that of the accompanying user charge proposal.

3.0 GENERAL COMPARISON OF TRANSPORTATION MODES

Shippers must make a selection of which mode is most advantageous in a particular instance. Four principal characteristics which influence modal selection have been identified in a number of transportation studies.[1] Those include cost, capacity, flexibility and speed. Brief descriptions of each characteristic for five major modes are shown in Table 1.

It is clear from this Table that motor carrier transportation is the most flexible mode, allowing the shipment of all cargoes between all points. Rail shipment is second, limited by the fact that fewer locations are situated on railroad tracks than on highways. The marine mode, capable of moving many cargoes between origins and destinations located on navigable waterways and possessing dock facilities, follows motor carrier and rail in order of flexibility. Both of the remaining modes are much less flexible. Pipelines can accommodate only a limited range of cargoes, principally liquids or gas, between pipeline terminals. Air shipment can be utilized only between airports, thus severely limiting its flexibility. Whenever air transportation is used, another mode, typically truck, is required for pick up and delivery service. This further restricts the flexibility of the air freight mode.

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[1] A.T. Kearney, Inc. for the Mid-America Regional Council, River Development Feasibility Study, Phase I Report, 1977, p. 15.

TABLE 1. CHARACTERISTICS OF MAJOR TRANSPORTATION MODES

Mode	Flexibility	Typical Unit Capacity (Tons)	Speed (mph)	Line-haul Cost (¢/ton-mile)
Marine	Many Cargoes Between Ports	1,000 to 60,000	3 to 30	0.3 to 1.1
Pipeline	Limited Cargoes Between Terminals	30,000 to 2,500,000	3 to 6 3 to 6	0.1 to 0.25 0.1 to 0.25
Rail	All Cargoes Between Rail Sidings	50 to 12,000	20 to 45 20 to 45	0.5 to 2.5 0.5 to 2.5
Motor Carrier	All Cargoes Between All Points	10 to 25	40 to 60	2.0 to 4.0
Airline	Many Cargoes Between Airports	5 to 125	300 to 600	15.0 to 20.0

Source: A.T. Kearney, Inc. for the Mid-America Regional Council, River Development Feasibility Study, Phase I Report, 1977, p. 16.

As used here, capacity refers to the size of typical individual shipments. Capacity of the several modes vary considerably, from 5 tons in some air transport situations to 2½ million tons at times by pipeline. This amounts to a potential factor between modes of 500,000. Transportation by pipeline has the greatest capacity with single shipments ranging from 10,000 tons to the previously mentioned 2½ million tons. The marine mode has the next greatest capacity, although significantly less than pipeline capacity. Typically marine quantity varies from 1,000 tons (1-barge tow) to 60,000 tons (40-barge tow). This is followed by the rail mode which transports between 50 tons (1 railcar) and over 12,000 tons (a unit train) in one shipment. There is a great disparity between rail and the remaining modes. The motor carrier mode typically transports a truck trailer weight of 10 to 25 tons. Air freight transports are close in capacity to the motor carrier and at times exceed it with a capacity of 5 to 125 tons (the latter is achieved in a 747 freighter).

Reference to speed concerns the time spent in transit between origin and destination. The airline mode is obviously far and away the fastest, ranging from 300 to 600 miles per hour. Motor carrier and rail are next in order of speed and are somewhat comparable, as truck speed varies from 40 to 60 mph and rail from 20 to 45 mph. Marine and pipeline are the slowest means of transporting goods averaging 3 to 30 and 3 to 6 mph respectively.

The costs indicated by Table 1 are line-haul costs which are those costs

associated with moving a shipment from origin to destination. There are additional costs incurred incidental to transporting various commodities. Those include terminal costs at origin and destination related to loading and unloading the cargo as well as feeder and distribution costs when more than one mode is used.

The five freight transportation modes are ranked in Table 2 according to the previously discussed characteristics. Reasoning used in ranking the modes is then given for each mode.

TABLE 2. RANKINGS OF MODES BY SELECTED CHARACTERISTICS

Least Cost	Greatest Capacity	Most Flexible	Greatest Speed
1. Pipeline	1. Pipeline	1. Motor Carrier	1. Airline
2. Marine	2. Marine	2. Rail	2. Motor Carrier
3. Rail	3. Rail	3. Marine	3. Rail
4. Motor Carrier	4. Motor Carrier	4. Pipeline	4. Marine
5. Airline	5. Airline	5. Airline	5. Pipeline

Source: A.T. Kearney, Inc. for the Mid-America Regional Council, River Development Feasibility Study, Phase I Report, 1977, p. 18.

3.1 Pipeline

Pipelines are used to move large quantities of gaseous and liquid substances although solids can also be transported by means of a slurry. Slurries are beginning to be used in the western portion of the Missouri Valley to move coal, however none have been extended as far east as Sioux City. Once in place pipelines provide low cost transportation, but substantial fixed costs are required to establish the pipeline network. Pipeline capacity is obviously dependent upon the size of pipe used. Due to costliness, however, a large committed volume is necessary prior to actually undertaking construction. Once operational pipeline transportation is highly inflexible, serving only a single route. The slow speed of piped material is a drawback of this mode.

3.2 Airline

Airline is the fastest and also the most costly means of transporting commodities. The size of individual shipments is limited by the capacity of the particular plane used. Although the number of established airports capable of handling air freighters is relatively large, the need to use such facilities restricts the mode's flexibility. Furthermore, transportation by air virtually always requires at least one additional mode, usually motor carrier, to complete the movement. Due to the limited capacity and high cost of airline transportation, it is most well-suited for the movement of small, perishable or highly valued cargoes. Since the advantage of the airline mode is primarily one of greater speed, the longer the distance a good is to be shipped, the more important the air advantage becomes.

3.3 Motor Carrier

Transportation by motor carrier is typified by relatively high costs and low capacities. Higher speed and increased flexibility are the principal advantages of using this mode rather than one of the others. The motor carrier mode is the only means of delivering most goods essentially anywhere at any time, limited solely by highway access. Trucking and warehousing is a vital part of the Sioux City transportation system, with sixty-one common carriers serving the City.

3.4 Rail

Rail transportation is near the mid-point of the rankings in Table 2, and therefore is a potential competitor of every other mode. The costs of moving goods by rail depend upon the actual costs of providing the service as well as the pricing and service policies of the particular railroad involved.

Certain extraordinary rail services, such as high speed, single car, refrigeration, or specialized cars, do cost more and therefore will usually necessitate higher prices. Generally rail rates are higher for higher valued cargoes. Rates are also influenced by the existence of competition from other rail companies or other modes. In transporting bulk items, the availability of water transportation often results in what are called "water compelled" rates and the offering of volume discounts. Water-compelled rates near the Missouri River have been determined to be approximately 10 to 12 percent less than averages of non-water compelled rates for similar shipping distances.[1]

3.5 Marine

As indicated by Table 2, the marine mode is particularly attractive as a means of transporting large quantities over a long distance at relatively low costs. Costs associated with marine movements, however, are not equal on all waterways. Missouri River movements are more expensive than corresponding movements on many other waterways, including the Mississippi. For example, the cost/ton-mile for shipping grain from Keokuk (on the Mississippi) to New Orleans was $0.38 in 1976, while the cost from Sioux City was $0.54.[2] This represents a 42 percent increase between Keokuk and Sioux City.

There are four characteristics of the Missouri River which make water transportation on it relatively less advantageous compared to other river systems as far as both cost and convenience are concerned. These include:

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[1] RMG Associates, Inc. for the Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, Jan. 1976, p. 67.

[2] Iowa Department of Transportation, Planning and Research Division, River Transportation in Iowa, May 1978, p. 75.

1. Circuity to various destinations
2. Lack of year-round navigation
3. Relatively fast currents
4. Unreliable channel depths[1]

Since water routes are dependent upon the courses taken by rivers in the system, they are rarely, if ever, the most direct means of moving between origin and destination. While cost/ton-mile may decline with greater distances, total cost must increase. Therefore, the cost advantage of shipping a good between point A and point B by water compared to rail (or some other mode) is reduced due to circuity of the water route. Circuity also makes the time advantage possessed by rail more pronounced. Table 3 indicates the circuity of the water routes between selected Missouri River ports and potential trading partners relative to the rail routes between the same locations.

This table shows that the distance between Sioux City and Omaha is 15 percent greater by water than by rail. Circuity of the water route from Sioux City to the remaining Missouri River ports becomes progressively larger as one moves downriver; from 1.15 at Omaha, to 1.22 at Kansas City, and finally to 1.45 at St. Louis. It is interesting to examine the circuity between the Missouri River ports and the major destination for grain shipments, New Orleans. Distance from Sioux City by water is 43 percent greater than by rail; compared to 45 percent at Omaha, 50 percent at Kansas City and 49 percent at St. Louis. This means that the line-haul cost advantage of marine over rail will be greater at Sioux City than at any of the other Missouri River ports as far as shipments to New Orleans are concerned.

The seasonal nature of navigation on the Missouri is another disadvantage of the river compared to other waterways. Even if it were possible to provide sufficient flows throughout the entire year, icing would prohibit winter navigation. At the present time, river shippers are confronted with three alternatives. Those include:

1. Discontinue shipments during the winter
2. Stockpile cargo for future shipment
3. Utilize an alternative mode throughout the winter months

Year-round navigation is not equally important in all industries. Nearly 50 percent of the commodities shipped to or from Sioux City consist of grains or agricultural fertilizers. Grains are commonly stockpiled and have a seasonal production pattern which is compatible with the navigation season. Similarly, fertilizers are applied at times of the year which correspond with the availability of river transportation. Therefore, it appears that Sioux City, due to its industrial mix, would be less adversely impacted by the lack of year-round navigation than those ports which ship goods more likely to require year-round transportation.

[1] A.T. Kearney, Inc. for the Mid-America Regional Council, River Development Feasibility Study, Phase I Report, 1977, p. 24.

TABLE 3. CIRCUITY OF WATER ROUTES RELATIVE TO RAIL ROUTES BETWEEN SELECTED PORTS

Rail Distance = 1.00

	Sioux City	Omaha	Kansas City	St. Louis	Chicago
Sioux City		1.15	1.22	1.45	2.12
Omaha	1.15		1.26	1.53	1.98
Kansas City	1.22	1.26		1.35	1.65
St. Louis	1.45	1.53	1.35		1.29

	St. Paul	Memphis	New Orleans	Houston
Sioux City	5.17	1.46	1.43	2.04
Omaha	3.63	1.51	1.45	2.13
Kansas City	2.09	1.61	1.50	2.36
St. Louis	1.15	1.30	1.49	1.82

Source: Official Railway Guide and Missouri River Navigation Charts as contained in A.T. Kearney, Inc. for the Mid-America Regional Council, River Development Feasibility Study, Phase I Report, 1977, p. 23.

Due to the fact that the Missouri River declines over 3,600 feet between its source in the Rocky Mountains and where it enters the Mississippi near St. Louis (A gradient of approximately 1½ feet per mile), predominant currents exceed those of many other navigable streams. For example, the Mississippi River flows north to south through lands which are much less diverse in elevation. This results in a lower gradient (about 1/3 foot per mile) and correspondingly slower currents. Towboats which operate on the Missouri must battle against these relatively fast currents upstream and maintain control of the barges in the rapid, swirling waters going downriver. Operating costs are increased due to higher levels of fuel consumption in swift water. Similarly, more rapid currents limit the number of barges per tow which can be safely managed. On the Missouri, the number of barges per tow ranges from 2 or 3 between Sioux City and Omaha, to 8 between Kansas City and the mouth; as compared to as many as 40 barges per tow on the lower Mississippi. Costs per unit of commodity shipped vary inversely with number of barges per tow. Therefore, such costs are necessarily greater on the Missouri than the lower Mississippi.

Due to the lack of a reliable 9-foot channel on all portions of the river, barges are typically transported at less than full capacity. Also non-uniform channel depths lead to groundings. Loading at less than full capacity to reduce draft increases per unit shipping costs as does the incidence of groundings. Table 4 details the average draft of loaded tows and the number of groundings per year on the river between Sioux City and Kansas City for the years 1966-76.

Generally channel depths have improved over the years as the channel has become more well trained. This is indicated by the increase in average draft of loaded tows from 6'6" in the early years of the period to well over 7 feet in the latter. Intermittent drouth conditions, however, result in reduced discharges from upriver dams which necessitate lighter loadings in those instances. The incidence of groundings is increased during such periods of drouth. Barge companies rely on channel depth data from the Corps of Engineers as well as their experience on the river to judge proper loading. Even reduced loading cannot completely eliminate groundings and the costly delays and damaged cargo they potentially can lead to. In 1976, when drafts were reduced, 22 groundings occurred, an average of more than one in every twenty trips. Similarly during the drouth of 1974, groundings occurred once in every ten trips. The inability to consistently transport a full load decreases the ability of water carriers to offer favorable rates.

TABLE 4. DRAFTS AND GROUNDINGS, 1966-76, SIOUX CITY TO KANSAS CITY

Year	Average Draft of Loaded Tows	Groundings, All Causes	
		Total Number	Ave. # per Trip
1976	7'4"	22	0.06
1975	7'7"	3	0.01
1974	7'3"	29	0.10
1973	7'9"	22	0.09
1972	7'8"	5	0.02
1971	7'9"	10	0.03
1970	7'4"	36	0.10
1969	7'3"	6	0.02
1968	6'6"	38	0.13
1967	6'6"	58	0.21
1966	6'6"	106	0.42

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1976 Missouri River Navigation, p. 6.

An analysis of the level and composition of commodity flows is essential to measuring the impact of user charges as their significance is a function of the magnitude and value of the commodities shipped. Therefore, the following sections will address the level of commercial river activity as well as the specific commodity mix.

4.0 HISTORIC AND CURRENT COMMODITY FLOWS

A description of the characteristics of past and present commodity flows for the entire Missouri River, and particularly the Sioux City to Omaha segment, is important to this study because such an evaluation is required in estimating transportation costs and waterway savings. While significant tonnages were shipped at times prior to 1955 (648,000 tons in 1941), commercial traffic didn't grow rapidly until after that date, and didn't reach meaningful levels at Sioux City till the mid 1960's.

Mention should be made of two types of cargo which are not included in the analysis of commercial traffic. Those include waterway improvement materials used in constructing and maintaining the Missouri River Bank Stabilization and Navigation Project as well as sand and gravel. The reasoning behind exclusion of the former is fairly obvious while exclusion of the latter is based upon the unique pattern of sand and gravel movements on the Missouri. The Missouri River itself, regardless of its navigability, is the major and least-cost source of sand and gravel deposits in the area. Furthermore, the average length one ton of sand and gravel is transported on the river is only 1.5 miles.

Table 5 presents a summary of commercial traffic movements on the entire Missouri River for selected years between 1965 and 1977. Table 6 contains corresponding data for that stretch between Sioux City and Omaha. In total tons of commodities shipped on the entire Missouri River, little change took place during the 1965-1975 decade. Dramatic growth has, however, occurred since 1975 with total tonnage increasing from 2.3 to 3.3 million (43.3 percent). The growth pattern on the Sioux City to Omaha portion is somewhat different. Between 1965 and 1975, total tonnage improved from approximately 83,000 to over 373,000 (a 348.6 percent increase). This increase is attributable to the fact that the marine mode was new and was becoming established during this period. From 1970 to 1977, tonnage grew 37.8 percent, slightly less than the rate for the river as a whole. Both the Sioux City to Omaha segment and the entire river declined in total tonnage between 1970 and 1975, the former 4.8 percent and the latter 11.4 percent.

In terms of specific commodities, the chemical group experienced far and away the greatest rate of growth for the stretch from Sioux City to Omaha and the entire river. For the Sioux City to Omaha segment, chemical movements increased over 50 fold, from 2,400 tons in 1965 to 120,500 tons in 1977; while for the entire river, tonnage grew by a factor of nearly 7, from 79,800 in 1965 to 546,600 tons twelve years later. Consisting primarily of fertilizer, most of the growth in chemical tonnage occurred between 1965 and 1970.

Other commodity groups experiencing significant growth in tonnage on the entire river between 1965 and 1977 include petroleum products (205.8 percent), metal products (105.3 percent) and food and kindred products (99.0 percent). The growth pattern over this period for the Sioux City to Omaha segment was different than that for the river as a whole. Food and kindred products exhibited the greatest rate of growth (657.0 percent), followed by farm products (421.0 percent) and nonmetallic minerals (119.3 percent).

It is evident that in terms of tonnage, farm products are the most important commodity group for the Missouri River in its entirety, although little, if any indications of growth can be seen in their past performance. The most striking characteristic apparent in examining the pattern of farm products movements is the instability of the amount shipped. Fluctuation in the record of farm products movements is clearly seen by noting that within the past five years shipments of corn have ranged from 21,700 tons in 1972 to 313,500 in 1974 (a factor of more than 14). Likewise wheat varied from highs of more than 1.0 million tons in both 1966 and 1967, to

TABLE 5. COMMERCIAL TONNAGE BY COMMODITY GROUP FOR SELECTED YEARS, 1965-1977, ENTIRE MISSOURI RIVER

	1965		1970		1975		1977	
	Total in 1,000s	% of Total	Total in 1,000s	% of Total	Total in 1,000s	% of Total	Total in 1,000s	% of Total
Farm Products	1,475.1	64.9	1,095.0	42.7	830.2	36.6	1,324.2	40.7
Metallic Ores	0.0	0.0	3.3	0.1	0.0	0.0	0.0	0.0
Nonmetallic Minerals	136.3	6.0	206.7	8.1	141.0	6.2	150.9	4.6
Food & Kindred Products	295.3	13.0	373.5	14.6	459.2	20.2	587.5	18.0
Textile Fibers	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	3.7	0.2	16.6	0.6	9.3	0.4	5.1	0.2
Chemicals	79.8	3.5	546.6	21.3	466.3	20.5	546.6	16.8
Petroleum Products	121.6	5.4	48.6	1.9	214.3	9.4	371.9	11.4
Stone & Clay Products	97.2	4.3	191.6	7.5	151.0	6.6	148.0	4.5
Metal Products	60.1	2.6	52.2	2.0	2.5	0.1	123.4	3.8
Machinery	2.4	0.1	2.1	0.1	0.0	0.0	0.8	0.0
Other Commodities	0.0	0.0	28.3	1.1	0.0	0.0	1.2	0.0
Total	2,271.5	100.0	2,565.2	100.0	2,273.8	100.0	3,259.6	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of Missouri River Navigation, 1965-1977.

TABLE 6. COMMERCIAL TONNAGE BY COMMODITY GROUP FOR SELECTED YEARS, 1965-1977, SIOUX CITY TO OMAHA

	1965		1970		1975		1977	
	Total in 1,000s	% of Total	Total in 1,000s	% of Total	Total in 1,000s	% of Total	Total in 1,000s	% of Total
Farm Products	24.3	29.2	93.1	24.9	34.1	9.6	126.6	24.6
Metallic Ores	0.0	0.0	3.3	0.9	0.0	0.0	0.0	0.0
Nonmetallic Minerals	23.3	28.0	44.3	11.9	48.8	13.7	51.1	9.9
Food & Kindred Products	27.2	32.7	113.2	30.3	119.1	33.5	205.9	40.1
Textile Fibers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemicals	2.4	2.9	118.2	31.7	138.1	39.0	120.5	23.4
Petroleum Products	0.0	0.0	0.0	0.0	2.3	0.6	0.0	0.0
Stone & Clay Products	0.0	0.0	0.0	0.0	1.9	0.5	0.0	0.0
Metal Products	6.0	7.2	0.0	0.0	11.0	3.1	10.2	2.0
Machinery	0.0	0.0	1.1	0.3	0.0	0.0	0.0	0.0
Total	83.2	100.0	373.2	100.0	355.3	100.0	514.3	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of Missouri River Navigation,1965-1977.

a low of 450,000 tons in 1973. Sorghum grains also exhibited marked variability with total tonnages of 33,000 in 1970, 233,500 in 1972, and 6,700 in 1974. The 1974 tonnage is less than three percent of the 1972 total.

Farm products is not the largest commodity group shipped between Sioux City and Omaha, however, considerable variability is present over that segment as well. Movements of farm products from Sioux City through Omaha totaled 93,112 tons in 1970, 47,840 in 1972, 133,842 in 1974, 34,146 in 1975, and 126,558 in 1977.

The reasons for the extreme fluctuation in farm products transportation may to a great extent be the result of forces other than the cost savings available on the waterways. Quite probably the variations in tonnages are due to changes in prices, including seasonal shifts, production levels due to poor weather and other factors, variations in domestic and foreign demands as well as the availability and changes in the cost of alternative modes, (especially rail). In summary it appears that there are a number of factors which work to determine the level of farm products movements irrespective of the existence of positive unit cost savings for the marine mode.

Another observation that appears to be true is that Missouri River navigation is primarily oriented toward serving agricultural and allied food processing sectors of the economy. For example, in 1977, 75.5 percent of the tonnage shipped on the entire river was in the three agriculturally related commodity groups: farm products, food and kindred products and chemicals. This is even more pronounced in the Sioux City to Omaha segment where over 88 percent of the tonnage moved was agriculturally oriented. The non-agricultural sectors seem to be less dependent upon the cost savings associated with the marine mode than is the case for the agricultural sectors.

4.1 Major Characteristics of Recent Commodity Flows

This section considers the major characteristics of recent commodity flows from the standpoint of volume as well as origins and destinations. As in the previous section, the entire Missouri River will be considered with particular emphasis placed on the Sioux City to Omaha segment. Traffic flows of 1972 will be analyzed rather than current flows because required origin/destination and ton-mile data were readily available for that year. With one exception, 1972 data appears sufficiently representative of movements since 1970. In 1972 the amount of corn moved by the marine mode was significantly lower than for most years in the period. Even with this shortcoming, the 1972 data is the best assemblage of detailed information available.

Since the benefits of a waterway project are a function of both total tonnage moved and average distance transported, it is of value to assess Missouri River commodity flows on a ton-mile basis. Tables 7, 8 and 9 contain total tonnages and 1972 ton-mile estimates both in terms of the Missouri River and the larger Mississippi-Gulf system, which includes those ton-miles occurring on the Missouri. For example, by looking at Table 7, which pertains to upstream movements, one can see that between origin and

TABLE 7. ANALYSIS OF MAJOR COMMODITY MOVEMENTS, 1972 (Inbound)

Inbound to Missouri River

Commodity Code	Commodity	Total Tonnage	Mississippi-Gulf System Ton Miles (Millions)	Mississippi-Gulf System Avg. Dist. (Miles)	Missouri River Ton Miles (Millions)	Missouri River Avg. Dist. (Miles)
TOTAL		1,060,155				
Major Commodities						
1442	Sand & Gravel	20,121	6.0	292.2	.6	29.8
1491	Salt	192,764	330.4	1,713.8	104.7	542.9
2042	Animal Feeds	18,745	21.1	1,123.5	11.3	600.2
2062	Molasses	228,500	358.7	1,569.8	134.3	465.5
2621	Newsprint	17,682	29.2	1,653.1	10.2	576.3
2810	Caustic Soda	17,785	23.0	1,293.8	6.4	360.0
2813	Alcohols	27,991	42.1	1,504.1	13.3	473.4
2819	Basic Chemicals	43,500	53.8	1,235.6	26.6	610.6
2871	Nitrogen Fertilizer	69,546	84.0	1,207.8	35.1	504.1
2873	Phospate Fertilizer	61,195	57.7	943.7	32.6	532.9
2879	Other Fertilizers	221,724	355.4	1,602.7	124.3	560.5
2911	Gasoline	62,862	9.5	151.1	9.3	148.0
3316	Iron & Steel Sheets	34,403	42.9	1,248.2	18.0	522.1
Total Major Commodities		1,016,818	1,413.8	1,390.4	526.7	518.0

Source: RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 12.

TABLE 8. ANALYSIS OF MAJOR COMMODITY MOVEMENTS, 1972 (Outbound)

Outbound from Missouri River

Commodity Code	Commodity	Total Tonnage	Mississippi-Gulf System Ton Miles (Millions)	Mississippi-Gulf System Avg. Dist. (Miles)	Missouri River Ton Miles (Millions)	Missouri River Avg. Dist. (Miles)
TOTAL		1,533,915				
Major Commodities						
0103	Corn	20,240	30.3	1,497.0	9.7	481.2
0106	Sorghum Grains	235,510	340.5	1,445.8	109.6	465.4
0107	Wheat	764,622	984.4	1,287.4	337.9	441.9
0111	Soybeans	89,913	131.6	1,463.6	38.7	430.8
1442	Sand & Gravel	82,500	.3	3.0	Less than .1	1.0
2014	Tallow, Fats	46,188	80.7	1,747.2	22.9	495.4
2041	Wheat Flour	63,378	88.8	1,401.1	24.5	386.1
2042	Animal Feeds	54,718	66.4	1,213.5	32.9	600.7
2049	Other Grain Mills	25,478	44.1	1,730.9	18.5	727.7
2091	Vegetable Oils	44,534	68.0	1,526.9	20.6	463.2
3241	Building Cement	23,523	17.4	739.7	8.3	354.0
4118	Waterway Materials	64.489	1.9	29.5	.5	8.0
Total Major Commodities		1,515,093	1,854.4	1,224.0	624.1	411.9
[(w/o 1442 & 4118)		1,368,104	1,852.2	1,353.8	623.6	455.8]

Source: RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 13.

destination, 1,413.8 million ton-miles were recorded, of which 526.7 million were on the Missouri River itself. Individual shipments moved an average of 1,390.4 miles with 518.0 of these being on the Missouri. Similar data for downstream movements is presented in Table 8 with information on local traffic (those movements taking place solely on the Missouri) contained in Table 9. Ton-mile estimates are presented for only the major commodities which represented 98 percent of the total tonnage shipped on the Missouri River in 1972.

In terms of ton-miles, salt, molasses and fertilizers constitute approximately 83 percent of the total upstream traffic on the Missouri River, similar to the relationship on the entire Mississippi-Gulf System. For downstream traffic, grains alone are about 80 percent of the total ton-miles on both river systems. While accounting for over 63 percent of total tonnage moved on the Missouri, local traffic (primarily sand and gravel and waterway improvement materials movements)accounts for only 4 percent of total ton-miles on the river.

Since it can be reasonably assumed that virtually all commercial movements transverse the entire Sioux City to Omaha segment, total ton-miles on this stretch of the river is directly proportional to total tonnages shipped. For the 1972 navigation season, salt, molasses and fertilizer accounted for over 98 percent of the upstream ton-miles on the Sioux City to Omaha segment. Of downstream traffic, grain movements constituted only .33 percent of total ton-miles, much less than for the river as a whole. Food and kindred products (principally tallow) shipments made up approximately 66 percent of the total ton-miles in that year. Ton-miles may be inferred for other years by analyzing the Tables contained in the appendix to this study which details commercial movements between Sioux City and Omaha for the 1964-1977 period.

Interestingly, nearly two-thirds of the ton-miles for all commodities shipped from or to Missouri River ports are recorded outside of the Missouri on other portions of the Mississippi-Gulf system. This indicates that much of the benefits of Missouri River navigation are dependent upon relatively long distance movements that can also utilize the cost savings afforded by the complete Mississippi-Gulf system.

TABLE 9. ANALYSIS OF MAJOR COMMODITY MOVEMENTS, 1972 (Local)

Commodity Code	Commodity	Total Tonnage	Missouri River Ton Miles (Millions)	Missouri River Avg. Dist. (Miles)
1442	Sand and Gravel	2,246,392	3.35	1.50
2871	Nitrogen Fertilizer	66,666	2.48	37.20
2879	Misc. Fertilizers	1,090	Less than .01	7.00
3241	Cement	160,863	3.38	21.00
4118	Waterway Materials	2,082,037	37.32	18.00

Source: RMG Associates, Inc. for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 14.

4.2 Missouri River Traffic by Segment

Although the navigable channel of the Missouri has a controlled depth of 8.5 feet over most of its entirety between Sioux City and the mouth (about 732 miles), significant differences in movements are present within its major segments. Those segments include Sioux City to Omaha (119 miles), Omaha to Kansas City (250 miles) and Kansas City to the mouth (363 miles). On a ton-mile basis, approximately 71 percent is recorded between Kansas City and the mouth, 26 percent between Kansas City and Omaha and 3 percent between Omaha and Sioux City. The 3 percent ton-mile figure is somewhat misleading because the distance between Sioux City and Omaha is the shortest of the three segments. During 1977 15.8 percent of the total tonnage shipped on the Missouri moved on this segment. Also, ton-miles for either of the other segments include movements originating in or destined for Sioux City since that port is the uppermost point of navigation on the Missouri. This division among segments is important, however, and should not be minimized due to the substantial cost differentials for tows and barges operating on the lower river between Kansas City and the mouth and those segments upriver from Kansas City.

4.3 Major Origins and Destinations

Since transportation costs are a function of several factors including distance moved, it is necessary to examine average distances of commodities transported and identify the more important origin/destination pairs for major commodities. Table 10 presents detailed origin/destination data for those important commodities having Sioux City as a terminus.

The nine commodities detailed in Table 10 represent over 60 percent of the commercial tonnage arriving at or departing from Sioux City in 1972. In terms of commodities shipped to Sioux City, the most important origins are those ports on the lower Mississippi including several on the Gulf Intercoastal Waterway. The major receivers of commodities originating in Sioux City are the numerous dock areas between Baton Rouge and New Orleans. It is probable that most of the grain moving from Sioux City to the Baton Rouge/New Orleans area is for export to foreign markets. In 1974, more than 50 percent of the grain bound for New Orleans was for export, and it is likely that much the same was true for Baton Rouge.[1]

Since the 1972 study was conducted, soybean meal has become a major commodity shipped from Sioux City. As is true of other agricultural products, gulf ports are the primary destination for soybean meal.

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[1] RMG Associates, Inc. for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 21.

TABLE 10. ANALYSIS OF ORIGINS/DESTINATIONS FOR SELECTED COMMODITIES HAVING SIOUX CITY AS A TERMINUS, 1972

Major O & D Shipping	Receiving	Total Tons	Ton-miles (Millions)	Av. Distance (Miles)
Salts				
Belle Isle, LA---	Sioux City	39,307	73.97	1,882
Molasses				
Baton Rouge-----	Sioux City	13,614	22.46	1,650
Fertilizers				
Harlem, LA------	Sioux City	40,763	74.30	1,828
New Orleans-----	Sioux City	5,157	9.17	1,773
St. Charles, LA-	Sioux City	13,387	23.55	1,759
Sorghum Grains				
Sioux City-	New Orleans/Baton Rouge	3,360	5.64	1,678
Wheat				
Sioux City----	All Destinations	16,195	26.02	1,606
Soybeans				
Sioux City-	New Orleans/Baton Rouge	17,880	31.25	1,748
Tallow, Fats				
Sioux City------	New Orleans	36,356	65.58	1,779
Other Grain Mills				
Sioux City-	New Orleans/Baton Rouge	25,478	44.08	1,730
Vegetable Oils				
Sioux City------	New Orleans	1,434	2.55	1,778
Total All Commodities		212,931	378.57	1,746

Source: Unpublished U.S. Army Corps of Engineers' Data as contained in RMG Associates, Inc., Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, pp. 17-20.

4.4 Modal Splits for Selected Commodities

In regard to commodity flows, it is interesting to note what proportion of the total amount of particular commodities shipped to or from the Missouri River ports is moved via the waterway. The resulting modal split gives an idea of the relative importance of the marine mode and the degree to which it is being utilized.

Recent studies have estimated the modal split for several major commodity groups. Those considered are listed below with an (i) or (o) indicating whether the principal Missouri River movements are inbound or outbound.[1]

Farm Products	(o)
Food and Kindred Products	
Grain mill products	(o)
Molasses	(i)
Other	(i)
Pulp and paper	(i)
Chemicals	(i)
Petroleum	(i)
Primary metals	(i)

Table 11 contains estimates of the waterborne percentage of the total amounts of various commodities shipped in the Missouri River Basin. Figures are for 1969, however their reasonableness has been somewhat substantiated through testing against 1974/75 data. The relative nearness of the two sets indicates that the data is probably of acceptable accuracy. It is clear that marine movements represent a comparatively small proportion of total commodity movements.

TABLE 11. MODAL SPLIT FOR SELECTED COMMODITIES MOVED ON THE MISSOURI RIVER, 1969 and 1974/75

Commodity by Group	Percent Waterway 1969	Percent Waterway 1974-1975
Farm products	17	16
Food and kindred products	6	12
Pulp and paper	3	1
Chemicals	22	17
Petroleum	9	14
Primary Metals	13	9

Source: RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 38.

[1] RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 37.

5.0 TRANSPORTATION ECONOMICS

This section attempts to briefly evaluate the costs involved with transporting commercially on the Missouri River and the costs of shipping by alternative modes. While it is more precise to consider total distribution costs incurred with each mode, the simplifying assumption of only considering line-haul costs has been made in this study. The end result of this effort will be a measure of the cost savings afforded by the marine mode relative to the least cost alternative (primarily rail). This cost differential becomes the important standard against which the impact of various waterway user charges can be measured.

5.1 Waterway Costs

The first step in developing relevant alternative transportation costs is determining the costs of transporting via water. Some general statements concerning water transportation on the Missouri should be made. First of all, it must be noted that the majority of movements on the Missouri River are either inbound or outbound, rather than local, and move relatively long distances on the lower-Mississippi River system. It can also be stated that generally tow sizes tend to be somewhat smaller on the Missouri than on the lower Mississippi. Considerable differences also exist between the Missouri and other navigable waterways in terms of delays, headway, and other operational considerations. These differences greatly influence the costs of transporting on the Missouri relative to other waterway systems. To properly measure the costs of shipping to or from Missouri River ports, it is necessary to determine costs on other waterway systems which connect with the Missouri as well as costs on the river itself.

Before discussing specific water costs, it is useful to examine regulatory and rate setting aspects of water carrier operation since they differ considerably from those prevailing for other modes. Presently several modes are regulated to varying degrees under provisions of the Interstate Commerce Act. Rail and motor carriers are subjected to the most stringent regulations while domestic water transportation, although the subject of generally increasing regulation, is still only partially regulated today. Much waterborne shipping is exempt from regulation, and regulation where it does exist is primarily confined to rate structure.

The most important of all exemptions from ICC regulation is for waterway operations operating as common carriers of bulk commodities. Commodities which have been specifically exempted are contained in Table 12. As indicated by this Table, many of the commodities transported on the Missouri are exempt from ICC regulation.

One consequence of this lack of regulation is that the ICC publishes no data with which barge rates can be constructed. Even when regulation is present, individual carriers report only gross revenues and gross tonnages with no indication of lengths of haul. Barge rates for the Missouri River are published by the Waterways Freight Bureau, however since barge operators are not bound by these rates, they do not give a complete picture of the charges assessed for movement by water. Actual rates under which commodities

move by barge are the result of negotiations between individual shippers and the barge companies. The negotiations are usually in terms of "percent of tariff" with barge firms reducing their rates during periods of low demand and increasing them when demand rises. Therefore, to estimate actual charges, it becomes necessary to know both the rate and percent of tariff in effect at any particular time. A survey of medium to large-size shippers was conducted during the period January 1973 to December 1974 in order to estimate the percent of tariff in effect. Executives of those firms contacted expressed the belief that the percentages then in effect would be representative of future percents of tariff during periods of moderate to heavy demand.[1]

TABLE 12. COMMODITIES EXEMPT FROM ICC REGULATION

Alumina	Granite	Rye
Barley	Gravel	Salt
Cinders	Wood Chips	Sand
Coal	Iron Ore	Shells
Coke	Molasses	Slag
Corn	Oats	Soda
Flax Seed	Ores	Stones
Grain	Phosphate Rock	Sulphur
	Tallow	Wheat

Source: RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 54.

While these percentages of tariff are for the upper-middle Mississippi River, they are indicative of rate fluctuations occurring on the Missouri. Larger firms often contract for a fixed number of barges each month. In return they are guaranteed freight rates which are usually 100 percent of tariff (the rate published by the Waterway Freight Bureau). In some cases approximately one-quarter of a firm's total tonnage may be under contract (100 percent of tariff). As a result, the average percent of tariff in effect is somewhat less than the negotiated percent. Table 13 presents the negotiated, contract and a weighted percent of tariff based upon the relationship of the negotiated and contract percents in effect during various portions of the shipping season.

The next step is to determine relatively current barge rates as published by the Waterways Freight Bureau for shipments to and from Sioux City. The prevailing 1978 rate for agricultural commodities transported from Sioux

[1]Iowa Department of Transportation and Iowa State University of Science and Technology, An Economic Analysis of Upgrading Rail Branch Lines: A Study of 71 Lines in Iowa, March 1976, p. 34.

City to New Orleans is $11.10/ton, with other commodities assessed rates between $13.90 and $14.80/ton. By applying the percents of tariff contained in Table 13 to these rates, total marine freight charges can be estimated, as shown in Table 14.

TABLE 13. TYPICAL NEGOTIATED, CONTRACT, AND WEIGHTED AVERAGE PERCENT OF BARGE TARIFFS ON THE UPPER MIDDLE MISSISSIPPI RIVER, JANUARY 1973 TO DECEMBER, 1974

Months[1]	Negotiated Percent of Tariff	Contract Percent of Tariff	Weighted Percent of Tariff
April-June	125	100	118.75
July-September	100	100	100.00
October-December	140	100	130.00

Source: Iowa Department of Transportation and Iowa State University of Science and Technology, An Economic Analysis of Upgrading Rail Branch Lines: A Study of 71 Lines in Iowa, March 1976, p. 33.

TABLE 14. MARINE FREIGHT CHARGES BETWEEN THE PORTS OF SIOUX CITY AND NEW ORLEANS, 1978 ESTIMATE

AGRICULTURAL COMMODITIES (Grain)

Months	Rate ($/Ton)	Weighted Percent of Tariff	Estimated Marine Charge ($/Ton)
April-June	$11.10	118.75	$13.18
July-September	11.10	100.00	11.10
October-December	11.10	130.00	14.43

NON-AGRICULTURAL COMMODITIES

Months	Rate[2] ($/Ton)	Weighted Percent of Tariff	Estimated Marine Charge ($/Ton)
April-June	$14.35	118.75	$17.04
July-September	14.35	100.00	14.35
October-December	14.35	130.00	18.66

Source: Computed from data provided by the Iowa Department of Transportation and material contained in Table 13.

[1] Insignificant movements during the winter months, January-March.

[2] Midpoint of non-agricultural range.

The impact of any water user charge proposal would necessarily have to be measured against that mode of transportation deemed to be the least cost alternative to the marine mode. There appears to be three possible least cost alternatives to shipping by water for both inbound and outbound movements and two alternatives for movements entirely within the Missouri River Basin. Possible least cost alternatives are contained in the following table.

TABLE 15. POSSIBLE LEAST COST ALTERNATIVES TO THE MARINE MODE

Shipment Type	Possible Least Cost Alternative
Inbound	A. Barge to Mississippi River Port--Rail to Destination
	B. Barge to Mississippi River Port--Truck to Destination
	C. All Rail--Origin to Destination
Outbound	A. Rail to Mississippi River Port--Barge to Destination
	B. Truck to Mississippi River Port--Barge to Destination
	C. All Rail--Origin to Destination
Internal	A. All Rail--Origin to Destination
	B. All Truck--Origin to Destination

Source: Adapted from data contained in RMG Associates, Inc. for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January 1976, p. 48.

To precisely determine which alternative would be utilized by shippers should the marine mode lose its cost advantage, consideration would have to be given to total distribution cost factors including inventory carrying costs for time in transit, costs of alternative inventory policies and other such costs for each individual mode. An undertaking of that magnitude is clearly far beyond the scope of this study. Therefore, some assumptions must be made which allow for selection of a least cost alternative without the above-mentioned cost data. First of all, since most commodities shipped to or from Sioux City originate in or are bound for Gulf ports, the selection of a least cost alternative is not necessary for internal movements (those completely between two Missouri River ports). Secondly, because commercial traffic to or from Sioux City primarily involves the long distance shipment of bulk commodities, it appears logical that the bimodal alternative utilizing barge movements on the Mississippi and truck transportation in the Missouri River Basin should be excluded from consideration as far as Sioux City movements are concerned. The primary reason for such a conclusion stems from the cost advantages enjoyed by rail relative to motor carrier transportation in the movement of bulk commodities over long distances. This narrows the modal choice to either a rail/barge combination or complete rail transportation. Because of the increased costs which would necessarily be involved in transferring between modes in a rail/barge combination, this alternative would probably be more costly than the all rail alternative. Also the combination alternative would increase total shipping time which results in higher costs. Cargo shrinkage is increased each time the shipment is handled. The rail/barge alternative requires the transfer between rail car and barge and would therefore be accompanied by increased costs due to shrinkage. For these reasons, the least cost alternative utilized in the

study will be assumed to be the all rail alternative. It is recognized that in some specialized instances the rail/barge combination, or even trucking, may constitute the least cost alternative.

5.2 Rail Costs

Railroads are regulated by the Interstate Commerce Commission which is responsible for rate approval. ICC rules dictate that all rates be "just and reasonable", which in practice has come to mean that they are compensatory. By compensatory it is implied that every rate must be sufficient to recover all out-of-pocket costs expended in providing the required services. Currently, there are actually hundreds of thousands of individual tariffs on file with the ICC. Each of these tariffs, which are usually set by carriers or rate bureaus, specifically sets forth the terms under which the freight is to be transported. Conditions set forth include precise "points of origin and destination, specific commodity to the lowest level of disaggregation possible, as well as provisions for special handling, transit privileges, etc."[1] Determination of exact tariffs for each specific commodity shipped to or from Sioux City is a task which is clearly beyond the scope of this study. Additionally, in some instances aggregation of individual commodity origin/destination data for Sioux City to the necessary level of detail would create disclosure problems for individual business operations.

There are two characteristics of rail revenues which need to be pointed out. First of all, rail rates tend to be markedly non-linear with respect to length of haul. In other words, on a dollars/ton-mile basis, the rail rate for shipment of a given commodity a distance of 1500 miles will be considerably lower than the rate for moving the same commodity only a few hundred miles. Rail movements competing with water shipments tend to be the lower cost, long distance transfers rather than the short distance hauls. A second observation is that rail rates, in terms of dollars per ton, tend to reflect the value of the goods transported. The significance of this is only to note that the railroads compete with the marine mode for lower value goods and with motor carriers for higher value goods. In areas where railroads are in competition with water carriers, the railroads have tended to reduce rates in order to maintain market shares. These "water-compelled" rates are justifiable from an economic standpoint provided that they exceed long-run variable costs which have been established by the ICC as the lower limit for rail rates. A 1976 study prepared for the Corps of Engineers determined that at that time rates near the Missouri River tended to be 10-12 percent lower than average non-water compelled rates for shipping distances of similar lengths.[2]

Due to the importance at Sioux City of the farm products and chemicals commodity groups, some mention should be made concerning their transportation by rail. Cash grains make up the farm products group while fertilizers constitute the major component of the chemicals group.

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[1] RMG Associates, Inc., for the U.S. Army Corps of Engineers, Missouri River Division, Missouri River Navigation and Bank Stabilization Project: Analysis of Commodity Flows and Navigation Benefits, January, 1976, pp. 64-65.

[2] ibid, p. 67.

The principal grain markets and milling centers of the Midwest are located with good transportation connections to areas of dense grain production. Primary intermodal competition between rail and water to be considered in this study is for shipments from the terminal market of Sioux City to Gulf ports from which exports can be made to foreign countries. Since total transportation costs are a significant portion of the final market price of this relatively low value commodity, rate competition is intense. Thus, grain merchandisers are sensitive to least cost alternatives of cargo movement. The demand for transportation by any single mode is quite elastic. Therefore, higher transportation costs for a particular mode (water, for example) will result in considerable shifts to competing modes (in this case, rail).

Rail tariffs available in Iowa before late 1971 were all single-car rates, or as they are often referred to as,random car rates. At that time, a multiple-car tariff was established for 27 and 54-car shipments bound for export at Houston, Texas. This was followed by 25 and 50-car export rates to Chicago and New Orleans as well as a special 3-car rate offered by one rail company on export movements to the Gulf. Some of the large multiple car rates often require commitment to at least five consecutive shipments.

The sources of fertilizer used in Iowa depend upon the specific type under consideration. Almost all phosphate fertilizer originates in central Florida. Potash for use in Iowa is mined in Saskatchewan, Canada. Urea imported into the United States is shipped to Donaldsonville, Louisiana or Houston, Texas. Additionally, large domestic urea production plants are located in and around Donaldsonville due to an abundance of natural gas which is necessary in urea production. Another type of fertilizer, ammonium nitrate, usually originates in two relatively local areas, Clinton, Iowa or Beatrice, Nebraska. Based upon these facts, it appears that in only two instances will rail and water be in competition. Those include urea movements from Donaldsonville to Sioux City and phosphate compounds from Donaldsonville to Sioux City as part of combination rail/water movement from central Florida.

The potash and ammonium nitrate movements would, based upon their points of origin, appear not to involve Missouri River movements to Sioux City. For that reason these will not be considered.

The methodology utilized in estimating rail rates for grains and fertilizers shipped to and from Sioux City involves inflating 1974-75 rates so as to allow for increases which the ICC has allowed since that time. Resulting from this effort will be costs which are comparable to the marine costs contained in Table 14. Pertinent rail cost data is presented in Table 16.

The combination rail/barge movement for phosphate fertilizer was excluded from Table 16 because the cost of such transportation is greater than the all rail alternative. Single-car rail rates from Central Florida to Sioux City are approximately $25.75/ton; while movements by rail within Florida to the Coast, ocean barge to Louisiana and river barge to Sioux City totals between $28.30 and $32.61, depending upon when the shipment

is made.[1] Costs of the intermodal movement is increased due to transfers from rail car to ocean barge, and ocean barge to river barge. Each additional transfer materially adds to the total cost of transportation. In addition, shrinkage will also be increased because of transfers.

TABLE 16. RAIL FREIGHT CHARGES BETWEEN SIOUX CITY AND NEW ORLEANS/ DONALDSONVILLE, 1978 ESTIMATE

AGRICULTURAL COMMODITIES (GRAIN)

Size of Shipment	Estimated Rail Charge ($/Ton)
Single-car	$17.91
3-car	17.11
25-car	16.38
50-car	14.98

FERTILIZER (UREA)

Size of Shipment	Estimated Rail Charge ($/Ton)
Single car	$28.18
10-car	19.22

Source: X Parte 305-A rates as contained in Iowa Department of Transportation and Iowa State University of Science and Technology, An Economic Analysis of Upgrading Rail Branch Lines: A Study of 71 Lines in Iowa, March 1976, pp. 40 and 47, adjusted and inflated to approximate current X Parte 349 rates according to data provided by the Iowa Department of Transportation.

5.3 Modal Cost Comparisons

Contained in Table 17 are the approximate unit cost savings per ton for two major commodity groupings moving on the Missouri River to Sioux City. These are measured as the difference between the estimated water charge and the least cost alternative, assumed to be the all rail movement. This table minimizes the waterway unit savings by listing only the least costly of the several rail alternatives, the 50 car shipment. The magnitude of the rail/water differential is significant as far as measuring the impact of various water user charges to be developed in the subsequent section.

[1] Rail and rail/barge charges were estimated by adjusting and inflating 1974 75 rates as contained in Iowa Department of Transportation and Iowa State University of Science and Technology, An Economic Analysis of Upgrading Rail Branch Lines: A Study of 71 Lines in Iowa, March 1976, p. 53, to approximate 1978 conditions.

TABLE 17. ESTIMATED UNIT WATERWAY SAVINGS, 1978

Type of Shipment	Estimated Charges[1] ($/Ton) Waterway	Rail	Unit Savings ($/Ton)
Agricultural Commodities (Grain)			
April-June	$13.18	$14.98	$1.80
July-September	11.10	14.98	3.88
October-December	14.43	14.98	0.55
Non-Agricultural Commodities (Fertilizer)			
April-June	$17.04	19.22	$2.18
July-September	14.35	19.22	4.87
October-December	18.66	19.22	0.56

Source: Derived from comparison of Tables 14 and 16.

6.0 SELECTED WATERWAY USER CHARGE PROPOSALS

As mentioned previously in this study, a waterway user charge, by definition, must be designed to recoup Federal outlays from the direct users of the public improvements which such outlays finance. The principal of user charges dictates that charges be assessed as nearly as practicable to those groups or individuals directly benefiting from the Federally funded facility, rather than some other group of taxpayers. To the extent that the payment of any charge is distributed without regard to direct benefits, it ceases to be a user charge.

Many user charge proposals have been advanced throughout the years; however they generally fall into several broad categories. One such category involves segment tolls which are based upon the fact that Federal costs per unit of commercial traffic moved varies enormously between the various navigable rivers and canals in different areas of the country. For example, according to the U.S. Army Corps of Engineers, annual Federal costs incurred between FY 1970 and 1974, per ton-mile of commercial traffic shipped during calendar year 1973 on the Missouri River totaled 13.90 mills, while only 0.13 mills on the lower Mississippi.[2] Therefore, it would appear that Federal outlays per ton-mile of commercial traffic are over 100 times greater on the Missouri. In order to adequately reimburse the government, segment tolls on each portion of the national waterway system would be differentiated in relation to both Federal cost and commercial traffic. Taxes on fuel consumed by commercial haulers is another frequently proposed user charge type. Such taxes do not, however, differentiate between users of the various navigable waterways which, as has been pointed out, vary greatly in terms of cost and traffic. As a result, such proposals actually advocate an excise tax

[1] Least costly of the all-rail alternatives.

[2] National Waterways Conference, Inc., Waterway Commerce, National Priorities and User Charges, October 1975, p. 20.

rather than a true user charge. A third category utilizes lockage fees, whereby users of locks on those rivers requiring them would be assessed a passage fee set in accordance with the cost of operating and maintaining the locking system.

The specifics of actual proposals which have been submitted to Congress should be examined at this time, particularly as they pertain to that stretch of the Missouri River between Sioux City and Omaha. Lockage fees will not be mentioned due to their lack of relevance to Missouri River navigation.

At least six bills proposing segment tolls have been introduced recently in Congress. H.R. 5885 and S. 790 submitted in June and February of 1977 respectively, each called for scaled government recovery of 100 percent of the operation and maintenance (O and M) costs for all segments of each navigable American waterway and 50 percent of the capital expenditures on new construction and rehabilitation. In the first year of the program, the water user charge would be set at a level sufficient to recover 20 percent of the O and M expenditures for each segment. This level would increase 20 percent each year until all such costs are recovered. Six years after enactment, the user charge would increase so as to recoup 10 percent of the new construction and rehabilitation costs if any, as well as all O and M expenditures. The recovery of construction and rehabilitation costs increase by 10 percent annually until 50 percent of these costs are being recovered. Thus, in the tenth year following enactment of this bill and each succeeding year, 100 percent of the O and M costs as well as 50 percent of the new construction and rehabilitation costs will be recovered by the Federal government through user charges.

In order to assign a segment toll to the Missouri between Sioux City and Omaha, it is necessary to determine the expected Federal outlays for O and M as well as the total ton-miles shipped over that stretch of the river. According to the U.S. Army Corps of Engineers, $3,600,000 annually is a reasonable approximation of near-term future O and M expenditures between Sioux City and Rulo, Nebraska (234 miles). Of this amount, roughly 40 percent or $1,440,000 might well be expended in the 117 miles between Sioux City and Omaha. The Corps also stated that all O and M costs could not be assessed to navigation, but must be apportioned between navigation and bank stabilization. Since some structures, such as wing dikes, benefit both, it will be assumed in this study that O and M expenditures are distributed equally. This results in a Navigation-related O and M of $720,000.[1] If it is further assumed that all goods arriving at or leaving from Sioux City passed through Omaha, then total ton-miles on the segment in 1977 was approximately 60,178,365.[2]

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[1] U.S. Army Corps of Engineers, Missouri River Division statement of past and present situation.

[2] 514,345 tons x 117 miles = 60,178,365 ton-miles.

As mentioned previously the proposals call for implementing the O and M segment toll over a five year period; with 20 percent of the annual expenditure recovered in year one, increasing in equal increments until all such costs are recovered. Therefore $144,000, $288,000, $432,000, $576,000, $720,000 would be assessed in years one through five respectively to recover an annual O and M expenditure of $720,000. It might be reasonable to assume that total dollar requirements for O and M would increase if for no other reason than inflationary pressure. However, since all expenditures depend upon the level of Congressional appropriations, it is difficult to forecast with accuracy the nature and amount of any increase in Federal outlays for O and M.

Since the project between Sioux City and Omaha is essentially complete, no capital expenditures are anticipated. As a result, the segment toll will only require recovery of O and M costs and if the assumptions previously made hold true, will have to be set at the following levels.

Year One	0.24¢/ton-mile
Year Two	0.48¢/ton-mile
Year Three	0.72¢/ton-mile
Year Four	0.96¢/ton-mile
Year Five	1.20¢/ton-mile
Subsequent Years	1.20¢/ton-mile

The levels are dependent upon the total ton-miles transported remaining constant at 60,178,365. Carriers will, in that case, be assessed $0.28,[1] $0.56, $0.84, $1.12 and $1.40 per ton in years one through five respectively. All expenditures are recovered in the fifth and each subsequent year.

The second major group of user charge proposals utilizes imposition of a fuel tax on all fuel consumed in commercial navigation. Many suggested bills including HR's 8309, 8460 and 8533, propose gradually increasing fuel taxes assessed against commercial carriers using domestic waterways.

Key to measuring the impact of such proposals on the stretch of the Missouri between Sioux City and Omaha is the determination of reasonably accurate fuel requirements. Once this is accomplished, it becomes a relatively simple matter to multiply the amount of fuel consumed by the proposed tax rate in order to generate the approximate total cost of a fuel tax.

Unpublished Iowa Department of Transportation data used in developing that agency's water user charge proposal indicates that 1,144 gallons of fuel would be consumed in a trip from Sioux City to Omaha, and 1,831 gallons in an Omaha to Sioux City movement. The assumptions and intermediate computations used to calculate these totals are contained in Table 18. Approximate total costs of a fuel tax on the Missouri River between Sioux City and Omaha are as indicated in Table 19.

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[1] 0.24¢/ton-mile x 117 miles = $0.28/ton.

TABLE 18. FUEL CONSUMPTION CALCULATIONS, SIOUX CITY TO OMAHA

ASSUMPTIONS

1. Use of a 1500 hp. towboat
2. Rate of fuel consumed is 62.5 gal/hr.
3. Travel time Sioux City to Omaha is 18.3 hours; Omaha to Sioux City is 29.3 hours.
4. Two barges per tow
5. Capacity per barge is 1,050 tons

CALCULATIONS

1. 62.5 gal./hr. x 18.3 hrs./trip = 1,144 gals./downstream movement
2. 62.5 gal./hr x 29.3 hrs./trip = 1,831 gals./upstream movement

Source: Unpublished data of the Iowa Department of Transportation.

TABLE 19. ESTIMATED COST OF A FUEL TAX, SIOUX CITY TO OMAHA

Movement	Fuel Consumed	Tax Rate	Total Tax/ Movement
Downstream	1,144 gal.	$0.03	$34.32
Downstream	1,144 gal.	0.04	45.76
Downstream	1,144 gal.	0.06	68.64
Downstream	1,144 gal.	0.08	91.52
Downstream	1,144 gal.	0.10	114.40
Upstream	1,831 gal.	0.03	54.93
Upstream	1,831 gal.	0.04	73.24
Upstream	1,831 gal.	0.06	109.86
Upstream	1,831 gal.	0.08	146.48
Upstream	1,831 gal.	0.10	183.10

Source: Calculated from data contained in Table 18.

If, as indicated in Table 18, each barge has a capacity of 1,050 tons, then the total capacity of a two-barge movement would be 2,100 tons. Dividing the projected tax per movement by the tonnage shipped allows determination of the approximate increase in shipping costs per ton of commodity moved between Sioux City and Omaha. Such data is presented in Table 20.

The total number of movements to or from Sioux City is controlled by the number of movements required to transport the downstream tonnage, since outbound tonnage exceeds inbound amounts. It is obvious that before goods can be shipped from Sioux City by barge, the required barges must first be moved there.

In 1977, approximately 186,890 tons were shipped to Sioux City, while more than 328,455 tons were moved downstream. Based upon two 1,050-ton barges per tow, the number of movements to and from Sioux City would total 312 (156 upstream and 156 downstream). This results in the total fuel tax revenue generated between Sioux City and Omaha contained in Table 21.

TABLE 20. EFFECTS ON SHIPPING COSTS DUE TO SELECTED FUEL TAXES

Tax Rate ($/gal.)	Total Tax/Movement ($)	Capacity/Movement (Tons)	Increase in Shipping Costs ($/Ton)
0.03[1]	34.32	2,100	0.02
0.04	45.76	2,100	0.02
0.06	68.64	2,100	0.03
0.08	91.52	2,100	0.04
0.10	114.40	2,100	0.05
0.03[2]	54.93	2,100	0.03
0.04	73.24	2,100	0.03
0.06	109.86	2,100	0.05
0.08	146.48	2,100	0.07
0.10	183.10	2,100	0.09

Source: Derived from data contained in Tables 18 and 19 and related narrative.

TABLE 21. FUEL TAX REVENUE, SIOUX CITY TO OMAHA

No. of Downstream Movements	Tax Rate ($/gal.)	Total Tax per Movement	Total Recovery
156	0.03	$ 34.32	$ 5,354
156	0.04	45.76	7,139
156	0.06	68.64	10,708
156	0.08	91.52	14,277
156	0.10	114.40	17,846

No. of Upstream Movements	Tax Rate ($/gal.)	Total Tax per Movement	Total Recovery
156	0.03	$ 54.93	$ 8,569
156	0.04	73.24	11,425
156	0.06	109.86	17,138
156	0.08	146.48	22,851
156	0.10	183.10	28,564

Total Movements	Tax Rate ($/gal.)	Total Recovery
312	0.03	$13,923
312	0.04	18,564
312	0.06	27,846
312	0.08	37,128
312	0.10	46,410

Source: Derived from data contained in Table 20.

[1]Downstream movement; [2]Upstream movement.

The Sioux City to Omaha segment is obviously only part of a larger Sioux City to the Gulf movement. If both the fuel consumed and the cargo capacity per movement between each intermediate port are known, it is possible to calculate the cost of a fuel tax which would be assessed for shipments from Sioux City to New Orleans. Assumptions required to make the fuel tax calculations are indicated by Table 22, while the actual calculations are contained in Table 23.

TABLE 22. FUEL CONSUMPTION AND CARGO CAPACITY ASSUMPTIONS, SIOUX CITY TO NEW ORLEANS

1. Barges per movement for the various segments are:

   Sioux City to Omaha = 2
   Omaha to Kansas City = 4
   Kansas City to St. Louis = 6
   St. Louis to New Orleans = 30

2. Capacity per movement for the various segments is:

   Sioux City to Omaha = 2,100 tons
   Omaha to Kansas City = 4,200 tons
   Kansas City to St. Louis = 6,300 tons
   St. Louis to New Orleans = 31,500 tons

3. Fuel consumption per movement for the various segments is:

   Sioux City to Omaha = 1,144 gal.
   Omaha to Kansas City = 2,706 gal.
   Kansas City to St. Louis = 3,750 gal.
   St. Louis to New Orleans = 56,780 gal.

Source: Unpublished data of the Iowa Department of Transportation.

TABLE 23. FUEL TAX COST CALCULATIONS, SIOUX CITY TO NEW ORLEANS

Movement	Tax Rate	Tax/Movement	Increase in Shipping Costs ($/ton)
Sioux City-Omaha	$0.03	$ 34.32	$0.02
Omaha-Kansas City	0.03	81.18	0.02
Kansas City-St. Louis	0.03	112.50	0.02
St. Louis-New Orleans	0.03	1,703.40	0.05
		$1,931.40	$0.11
Sioux City-Omaha	0.04	$ 45.76	$0.02
Omaha-Kansas City	0.04	108.24	0.03
Kansas City-St. Louis	0.04	150.00	0.02
St. Louis-New Orleans	0.04	2,271.20	0.07
		$2,575.20	$0.14

TABLE 23. FUEL TAX COST CALCULATIONS, SIOUX CITY TO NEW ORLEANS (contd.)

Movement	Tax Rate	Tax/Movement	Increase in Shipping Costs ($/ton)
Sioux City-Omaha	$0.06	$ 68.64	$0.03
Omaha-Kansas City	0.06	162.36	0.04
Kansas City-St. Louis	0.06	225.00	0.04
St. Louis-New Orleans	0.06	3,406.80	0.11
		$3,862.80	$0.22
Sioux City-Omaha	0.08	$ 91.52	$0.04
Omaha-Kansas City	0.08	216.48	0.05
Kansas City-St. Louis	0.08	300.00	0.06
St. Louis-New Orleans	0.08	4,542.40	0.14
		$5,150.40	$0.28
Sioux City-Omaha	0.10	$ 114.40	$0.05
Omaha-Kansas City	0.10	270.60	0.06
Kansas City-St. Louis	0.10	375.00	0.06
St. Louis-New Orleans	0.10	5,678.00	0.18
		$6,438.00	$0.35

Source: Derived from data contained in Table 22.

Comparison of Tables 17 and 23 indicates that increases in shipping costs due to a fuel tax of between $0.03 and $0.10 per gallon of fuel consumed will not substantially erode the waterway unit savings between April and September. During the October-December period, however, the fuel tax will reduce the unit savings of water transportation versus rail by 20 to 64 percent. Nevertheless, it is apparent that even under these circumstances, water transportation will retain a cost advantage over the rail alternative.

In certain instances, combinations of these major groupings are advocated. For example, most segment toll proposals allow any fuel tax paid to be used as an offset against the segment toll. Similarly, the Iowa Department of Transportation proposed assessing a $0.03/gal. fuel tax in conjunction with a fee of $32.00/single lockage to recoup a portion of the Federal outlays similar to the level of recovery on highway projects (43 percent).

7.0 IMPACT OF USER CHARGE IMPOSITION

Now that the costs of various proposals have been approximated, there remains the task of measuring the impact imposition would have. Clearly any user charge will increase the costs of shipping via water and thus make the marine mode less attractive relative to other modes.

Due to the high cost/low volume nature of navigation between Sioux City and Omaha, imposition of a segment toll would have the greatest impact. The projected segment tolls of $0.28, $0.56, $0.84, $1.12 and $1.40/ton will significantly, and in some cases, entirely, remove the unit waterway savings contained in Table 17. It should be pointed out that these unit savings are on a complete origin to destination basis, whereas the segment toll has been assessed only between Sioux City and Omaha.

Further tolls would be levied on each downstream segment between Omaha and the Gulf Coast. While it is beyond the scope of this study to develop segment tolls for these stretches, it is possible segment tolls could result in cessation of navigation to Sioux City.

If segment tolls didn't immediately end navigation, one can easily envision how over time this could occur. Once implemented, the segment toll would cause those goods whose transportation by water is only marginally advantageous (waterway unit savings only slightly greater than the segment toll) to be moved by an alternate mode. This would result in fewer ton-miles over which to spread the segment's O and M costs, thus necessitating escalation of the toll. A vicious cycle of ever-increasing tolls and decreasing tonnages would continue until the toll reached such a level that all commercial traffic became economically unfeasible.

The negative impacts on navigation of a fuel tax are considerably less severe due to the lower rate at which they would be assessed. In the first five years following imposition on the Missouri between Sioux City and Omaha, increases in shipping costs would range from $0.02 to $0.09/ton compared with $0.28 to $1.40/ton under a system of segment tolls. Thus the increase in shipping costs due to a fuel tax are only 6½ to 7 percent as great as increases resulting from segment tolls.

Fuel taxes would not be nearly so likely to end navigation to Sioux City for two major reasons. First of all, the lower rates (smaller increases in shipping costs) mean that user charges will result in advantageous transportation costs via other modes for fewer commodities. Secondly, the rate is fixed at a certain amount per gallon of fuel consumed rather than at a level tied to recovery of various percentages of the total Federal outlay. As a result, any decrease in commercial traffic will not automatically result in large increases in the user charge per unit shipped. The susceptibility to the cycle of ever-increasing user charges which seems evident in discussing segment tolls is not as prominent in the case o of fuel taxes. While the fuel tax does not completely satisfy the definition of a true user charge, it does remove the marine mode from total Federal subsidy with a minimum of economic disruption.

Several other impacts appear obvious and should, therefore, be mentioned. If navigation ceases, areas served by this segment of the Missouri will lose their water-compelled rail rates, which, as mentioned earlier, can lower costs of transporting by rail an average of 10 to 12 percent. Should this occur, the resulting higher transport costs would in most instances be passed on to the consumer in the form of increased consumer prices. In the marketing of grain, however, transportation costs are absorbed by the

producer which indicates that reduced farm incomes would result. These phenoma would occur, although to a lesser extent, even if water compelled rates are not lost because any user charge would necessarily increase costs.

While consideration has been given in this study primarily to line-haul costs, in reality barge transportation is but part of a larger intermodal movement. The Iowa Department of Transportation has determined that truck-barge rates at 100 percent of tariff are advantageous compared to 50-car rail rates within a 25 mile radius of Sioux City in Iowa.[1] Any user charge will alter this relationship, shrinking the area of water cost competitiveness. A similar area of water cost advantage exists in South Dakota and Nebraska, although its size has yet to be determined.

If commercial traffic fails to grow (ceases to exist, declines or remains the same), the commodities now moved by water (or future growth which normally would move by water) would have to be shipped by alternate means, primarily rail. This would put additional pressure on what is at times already a heavily burdened mode. During the fall harvest, the demand for hopper cars is so great that it can't be adequately met. Grain shipped to terminals and subterminals can exceed capacity before sufficient rail space becomes available. This condition would be worsened to the extent that commodities are transferred from water to the rail alternative.

A final impact concerns those workers employed in barging activities. Recently 126 persons were identified at terminals in and around Sioux City as being employed in navigation-related positions (loading and unloading cargo, cleaning barges, as well as related supervisory personnel).[2] These individuals would lose their positions if navigation ceased or was significantly curtailed. Some of these jobs would possibly be offset by increases in employment in other modes to accommodate higher volumes which would occur as shipments are transferred from water to alternative means of transportation, however, it is unlikely such increases could completely compensate for the navigation losses. In addition, substantial capital investments in port facilities would be jeopardized by cessation of, or substantial reduction in, commercial traffic.

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[1] Iowa Department of Transportation and Iowa State University of Science and Technology, An Economic Analysis of Upgrading Rail Branch Lines: A Study of 71 Lines in Iowa, March 1976, p. 169.

[2] SIMPCO survey of local terminals for the U.S. Army Corps of Engineers.

CONCLUSION

It has been the aim of this study to determine the approximate shipping charges assessed in transporting commodities by water and by the least cost alternative, assumed to be rail. Once accomplished, these costs were compared to estimate the unit waterway savings. The costs of selected user charge proposals were ascertained and measured against the unit waterway savings. From that effort, it appears obvious that imposition of any user charge will adversely affect navigation between Sioux City and Omaha, but that effect will be minimized through use of a fuel tax rather than a segment toll.

APPENDIX

COMMERCIAL TONNAGE BY COMMODITY GROUP

SIOUX CITY TO OMAHA

1964-1977

Following is a series of tables detailing commercial tonnage by commodity group shipped between Sioux City and Omaha during the period 1964-1977. Specific commodities have been aggregated into several groups. Rather than list the components of each group in every table, they will be presented below and are applicable to subsequent tables.

Farm Products (Corn, Wheat, Sorghum Grains, and Soybeans)
Metallic Ores
Nonmetallic Minerals (Salt and Phosphate Rock)
Food & Kindred Products (Tallow, Flour, Molasses, Soybean Oil and Animal Feeds)
Textile Fibers (Twine)
Paper & Allied Products (Rafted Logs and Standard Newsprint)
Chemicals (Benzene, Paints and Fertilizer)
Petroleum Products (Gasoline, Fuel Oil, Tar, Coke and Solvents)
Stone & Clay Products (Cement, Lime and Materialite)
Metal Products (Iron and Steel Sheets, Bars, Plates and Scrap)
Machinery
Transportation Equipment

TABLE A-1

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1964

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	2,740	2,740	5.9	0.0	2.7	2.7	5.9
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	17,762	0	17,762	38.0	17.8	0.0	17.8	38.0
Food & Kindred Products	15,747	4,059	19,806	42.4	15.8	4.1	19.9	42.4
Textile Fibers	0	0	0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	6,401	0	6,401	13.7	6.4	0.0	6.4	13.7
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Machinery	0	0	0	0.0	0.0	0.0	0.0	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	39,910	6,799	46,709	100.0	39.9	6.8	46.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1964 Missouri River Navigation.

TABLE A-2

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1965

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	24,318	24,318	29.2	0.0	27.1	27.1	17.8
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	23,315	0	23,315	28.0	41.1	0.0	41.1	27.1
Food & Kindred Products	21,766	5,397	27,163	32.7	37.5	31.2	68.7	45.4
Textile Fibers	0	0	0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	2,400	0	2,400	2.9	8.8	0.0	8.8	5.8
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	5,985	0	5,985	7.2	6.0	0.0	6.0	3.9
Machinery	0	0	0	0.0	0.0	0.0	0.0	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	53,466	29,715	83,181	100.0	93.4	58.3	151.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1965 Missouri River Navigation.

TABLE A-3

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1966

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	21,955	21,955	18.2	0.0	49.0	49.0	18.0
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	19,554	0	19,554	16.2	60.6	0.0	60.6	22.2
Food & Kindred Products	36,748	8,007	44,755	37.1	74.3	39.2	113.5	41.7
Textile Fibers	0	0	0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	30,488	0	30,488	25.2	39.3	0.0	39.3	14.4
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	4,021	0	4,021	3.3	10.0	0.0	10.0	3.7
Machinery	0	0	0	0.0	0.0	0.0	0.0	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	90,811	29,962	120,773	100.0	184.2	88.2	272.4	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1966 Missouri River Navigation.

TABLE A-4

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1967

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	15,590	15,590	9.2	0.0	64.6	64.6	14.6
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	33,516	0	33,516	19.8	94.2	0.0	94.2	21.3
Food & Kindred Products	31,169	13,607	44,776	26.5	105.4	52.8	158.2	35.9
Textile Fibers	0	0	0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	71,277	0	71,277	42.2	110.6	0.0	110.6	25.1
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	3,482	0	3,482	2.1	13.5	0.0	13.5	3.1
Machinery	0	245	245	0.2	0.0	0.2	0.2	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	139,444	29,442	168,886	100.0	323.6	117.7	441.3	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1967 Missouri River Navigation.

TABLE A-5

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1968

SIOUX CITY TO OMAHA

	ANNUAL				CUMULATIVE (In 1,000s)			
Commodity	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	15,346	15,346	7.3	0.0	80.0	80.0	12.3
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	19,069	0	19,069	9.1	113.2	0.0	113.2	17.4
Food & Kindred Products	36,961	16,806	53,767	25.6	142.4	69.6	212.0	32.5
Textile Fibers	0	0	0	0.0	0.0	0.0	0.0	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	118,587	902	119,489	56.7	229.2	0.9	230.1	35.3
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	2,770	0	2,770	1.3	16.2	0.0	16.2	2.5
Machinery	0	0	0	0.0	0.0	0.2	0.2	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	177,387	33,054	210,441	100.0	501.0	150.7	651.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1968 Missouri River Navigation.

TABLE A-6

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1969

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	106,812	106,812	31.8	0.0	186.8	186.8	18.9
Metallic Ores	0	0	0	0.0	0.0	0.0	0.0	0.0
Nonmetallic Minerals	40,289	0	40,289	12.0	153.5	0.0	153.5	15.6
Food & Kindred Products	27,856	44,984	72,840	21.8	170.3	114.6	284.9	28.9
Textile Fibers	514	0	514	0.2	0.5	0.0	0.5	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	94,706	10,463	105,169	31.4	323.9	11.4	335.3	34.0
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	9,301	0	9,301	2.8	25.6	0.0	25.6	2.6
Machinery	0	0	0	0.0	0.0	0.2	0.2	0.0
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	172,666	162,259	334,925	100.0	673.7	313.0	986.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1969 Missouri River Navigation.

TABLE A-7

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1970

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	93,112	93,112	24.9	0.0	279.9	279.9	20.6
Metallic Ores	3,300	0	3,300	0.9	3.3	0.0	3.3	0.2
Nonmetallic Minerals	44,321	0	44,321	11.9	197.8	0.0	197.8	14.5
Food & Kindred Products	29,069	84,174	113,243	30.3	199.4	198.8	398.2	29.3
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Chemicals	118,198	0	118,198	31.7	442.1	11.4	453.5	33.4
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	0	0	0	0.0	25.6	0.0	25.6	1.9
Machinery	1,144	0	1,144	0.3	1.1	0.2	1.3	0.1
Transportation Equipment	0	0	0	0.0	0.0	0.0	0.0	0.0
TOTAL	196,032	177,286	373,318	100.0	869.8	490.3	1,360.1	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1970 Missouri River Navigation.

TABLE A-8

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1971

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	61,637	61,637	15.3	0.0	341.5	341.5	19.4
Metallic Ores	0	0	0	0.0	3.3	0.0	3.3	0.2
Nonmetallic Minerals	36,145	0	36,145	9.0	233.9	0.0	233.9	13.3
Food & Kindred Products	35,218	126,246	161,464	40.0	234.6	325.0	559.6	31.8
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	636	0	636	0.2	0.6	0.0	0.6	0.0
Chemicals	140,010	2,019	142,029	35.3	582.1	13.4	595.5	33.8
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	0	0	0	0.0	25.6	0.0	25.6	1.4
Machinery	0	0	0	0.0	1.1	0.2	1.3	0.1
Transportation Equipment	900	0	900	0.2	0.9	0.0	0.9	0.0
TOTAL	212,909	189,902	402,811	100.0	1,082.6	680.1	1,762.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1971 Missouri River Navigation.

TABLE A-9

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1972

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	47,840	47,840	13.6	0.0	389.3	389.3	18.4
Metallic Ores	0	0	0	0.0	3.3	0.0	3.3	0.2
Nonmetallic Minerals	46,929	0	46,929	13.3	280.8	0.0	280.8	13.3
Food & Kindred Products	40,460	95,270	135,730	38.3	275.1	420.3	695.4	32.8
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	2,008	0	2,008	0.6	2.6	0.0	2.6	0.1
Chemicals	117,919	1,090	119,009	33.7	700.0	14.5	714.5	33.7
Petroleum Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	1,016	0	1,016	0.3	26.6	0.0	26.6	1.3
Machinery	0	0	0	0.0	1.1	0.2	1.3	0.1
Transportation Equipment	514	0	514	0.2	1.4	0.0	1.4	0.1
TOTAL	208,846	144,200	353,046	100.0	1,291.4	824.3	2,115.7	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1972 Missouri River Navigation.

TABLE A-10

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1973

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	67,671	67,671	23.0	0.0	457.0	457.0	19.0
Metallic Ores	0	0	0	0.0	3.3	0.0	3.3	0.1
Nonmetallic Minerals	42,042	0	42,042	14.3	322.8	0.0	322.8	13.4
Food & Kindred Products	19,694	96,046	115,740	39.4	294.8	516.3	811.1	33.7
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	695	0	695	0.2	3.3	0.0	3.3	0.1
Chemicals	54,651	1,023	55,674	18.9	754.7	15.5	770.2	32.0
Petroleum Products	9,528	0	9,528	3.2	9.5	0.0	9.5	0.4
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	2,811	0	2,811	1.0	29.4	0.0	29.4	1.2
Machinery	0	0	0	0.0	1.1	0.2	1.3	0.0
Transportation Equipment	0	0	0	0.0	1.4	0.0	1.4	0.1
TOTAL	129,421	164,740	294,161	100.0	1,420.8	989.0	2,409.8	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1973 Missouri River Navigation.

TABLE A-11

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1974

SIOUX CITY TO OMAHA

	ANNUAL				CUMULATIVE (In 1,000s)			
Commodity	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	133,842	133,842	41.6	0.0	590.8	590.8	21.6
Metallic Ores	0	0	0	0.0	3.3	0.0	3.3	0.1
Nonmetallic Minerals	40,931	0	40,931	12.7	363.7	0.0	363.7	13.3
Food & Kindred Products	15,265	57,449	72,714	22.6	310.1	573.7	883.8	32.5
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	1,076	0	1,076	0.3	4.4	0.0	4.4	0.2
Chemicals	69,602	0	69,602	21.6	824.3	15.5	839.8	30.7
Petroleum Products	3,686	0	3,686	1.2	13.2	0.0	13.2	0.5
Stone & Clay Products	0	0	0	0.0	0.0	0.0	0.0	0.0
Metal Products	0	0	0	0.0	29.4	0.0	29.4	1.1
Machinery	0	0	0	0.0	1.1	0.2	1.3	0.0
Transportation Equipment	0	0	0	0.0	1.4	0.0	1.4	0.0
TOTAL	130,560	191,291	321,851	100.0	1,551.4	1,180.2	2,731.6	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1974 Missouri River Navigation.

TABLE A-12

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1975

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	34,146	34,146	9.6	0.0	624.9	624.9	20.2
Metallic Ores	0	0	0	0.0	3.3	0.0	3.3	0.1
Nonmetallic Minerals	48,781	0	48,781	13.7	412.5	0.0	412.5	13.4
Food & Kindred Products	30,538	88,552	119,090	33.5	340.6	662.3	1,002.9	32.6
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	0	0	0	0.0	4.4	0.0	4.4	0.1
Chemicals	138,149	0	138,149	39.0	962.4	15.5	977.9	31.7
Petroleum Products	1,191	1,100	2,291	0.6	14.4	1.1	15.5	0.5
Stone & Clay Products	1,933	0	1.933	0.5	1.9	0.0	1.9	0.1
Metal Products	11,024	0	11,024	3.1	40.4	0.0	40.4	1.3
Machinery	0	0	0	0.0	1.1	0.2	1.3	0.0
Transportation Equipment	0	0	0	0.0	1.4	0.0	1.4	0.0
TOTAL	231,616	123,798	355,414	100.0	1,782.9	1,304.0	3,086.9	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1975 Missouri River Navigation.

TABLE A-13

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1976

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	0	79,559	79,559	16.0	0.0	704.5	704.5	19.7
Metallic Ores	551	0	551	0.1	3.9	0.0	3.9	0.1
Nonmetallic Minerals	47,391	0	47,391	9.5	459.9	0.0	459.9	12.8
Food & Kindred Products	44,609	216,001	260,610	52.6	385.2	878.3	1,263.5	35.4
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	0	0	0	0.0	4.4	0.0	4.4	0.1
Chemicals	94,114	1,180	95,294	19.2	1,056.5	16.7	1,073.2	30.0
Petroleum Products	2,494	0	2,494	0.5	16.9	1.1	18.0	0.5
Stone & Clay Products	0	0	0	0.0	1.9	0.0	1.9	0.0
Metal Products	10,649	0	10,649	2.1	51.0	0.0	51.0	1.4
Machinery	0	100	100	0.0	1.1	0.3	1.4	0.0
Transportation Equipment	0	0	0	0.0	1.4	0.0	1.4	0.0
TOTAL	199,808	296,840	496,648	100.0	1,982.7	1,600.9	3,583.6	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1976 Missouri River Navigation.

TABLE A-14

COMMERCIAL TONNAGE BY COMMODITY GROUP, 1977

SIOUX CITY TO OMAHA

Commodity	ANNUAL				CUMULATIVE (In 1,000s)			
	Upstream	Downstream	Total	Percent of Total	Upstream	Downstream	Total	Percent of Total
Farm Products	1,170	125,388	126,558	24.6	1.2	829.9	831.1	20.3
Metallic Ores	0	0	0	0.0	3.9	0.0	3.9	0.1
Nonmetallic Minerals	43,877	7,245	51,122	9.9	503.8	7.2	511.0	12.5
Food & Kindred Products	22,686	183,244	205,930	40.1	407.9	1,061.5	1,469.4	36.0
Textile Fibers	0	0	0	0.0	0.5	0.0	0.5	0.0
Paper & Allied Products	0	0	0	0.0	4.4	0.0	4.4	0.1
Chemicals	107,967	12,578	120,545	23.4	1,164.5	29.3	1,193.8	29.1
Petroleum Products	0	0	0	0.0	16.9	1.1	18.0	0.4
Stone & Clay Products	0	0	0	0.0	1.9	0.0	1.9	0.0
Metal Products	10,190	0	10,190	2.0	61.2	0.0	61.2	1.5
Machinery	0	0	0	0.0	1.1	0.3	1.4	0.0
Transportation Equipment	0	0	0	0.0	1.4	0.0	1.4	0.0
TOTAL	185,890	328,455	514,345	100.0	2,168.7	1,929.3	4,098.0	100.0

Source: U.S. Army Corps of Engineers, Missouri River Division, Summary of 1977 Missouri River Navigation.

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